

Environmental Challenges BUSINESS SOLUTIONS ®

Groundwater Plume Analytics for Assessing Remediation Effectiveness

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EarthCon Plume Analytics



Analytics is the discovery and communication of meaningful patterns in data. Especially valuable in areas rich with recorded information, analytics relies on the simultaneous application of statistics, computer programming and operations research to quantify performance. Analytics often favors data visualization to communicate insight.

- From Wikipedia, the free encyclopedia

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Presentation Overview



- Groundwater Plume Analytics
 - Ricker Method[®] Plume Stability Analysis
 - Spatial Change Analysis
 - Molar Data Analysis for Chlorinated Organics
 - Well Sufficiency Analysis

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Groundwater Plume Analytics Ricker Method[®] Plume Stability Analysis

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EarthCon Plume Analytics



Ricker Method® Plume Stability Analysis

- Methodology published in Groundwater Monitoring & Remediation 28, no. 4/ Fall 2008/pages 85–94
- Efficiently assimilates large volumes of historical data into a concise and meaningful analysis
- Empirical evaluation of plume stability metrics
 - Area
 - Average concentration
 - Mass
 - Center of mass
 - Plume spread of mass

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Groundwater Plume Analytics Spatial Difference Analysis

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Groundwater Plume Analytics Molar Data Analysis for Chlorinated Organics

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Example 2: 100% PCE degrades to: 25% PCE; 25% TCE; 25% DCE; 25% VC

Original Concentration			Final Con	<u>centration</u>	
3.32 kg	PCE	20 mol	0.83 kg	PCE	5 mol
0.00 kg	TCE	0 mol	0.66 kg	TCE	5 mol
0.00 kg	DCE	0 mol	0.48 kg	DCE	5 mol
0.00 kg	VC	0 mol	0.31 kg	VC	5 mol
3.32 kg	_	20 mol	2.28 kg	_	20 mol





Example 2: 100% PCE degrades to: 25% PCE; 25% TCE; 25% DCE; 25% VC

Original Concentration			Final Con	<u>centration</u>	
3.32 kg	PCE	20 mol	0.83 kg	PCE	5 mol
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0.00 kg	VC	0 mol	0.31 kg	VC	5 mol
3.32 kg		20 mol	2.28 kg		20 mol





Example 2: 100% PCE degrades to: 25% PCE; 25% TCE; 25% DCE; 25% VC

Original Concentration			<u>Fi</u>	Final Concentration		
3.32 kg	PCE	20 mol	0.	.83 kg	PCE	5 mol
0.00 kg	TCE	0 mol	0.	.66 kg	TCE	5 mol
0.00 kg	DCE	0 mol	0.	.48 kg	DCE	5 mol
0.00 kg	VC	0 mol	0.	.31 kg	VC	5 mol
3.32 kg	_	<mark>20 mol</mark>	2.	.28 kg	_	20 mol





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Example 3: 100% PCE degrades to 20% PCE; 20% TCE; 20% DCE; 30% VC

Original Concentration			Final Concentration		
3.32 kg	PCE	20 mol	0.66 kg	PCE	4 mol
0.00 kg	TCE	0 mol	0.53 kg	TCE	4 mol
0.00 kg	DCE	0 mol	0.39 kg	DCE	4 mol
0.00 kg	VC	0 mol	0.37 kg	VC	6 mol
3.32 kg	_	20 mol	1.95 kg	_	18 mol





Example 3: 100% PCE degrades to 20% PCE; 20% TCE; 20% DCE; 30% VC

Original Concentration			Final Con	<u>centration</u>	
3.32 kg	PCE	20 mol	0.66 kg	PCE	4 mol
0.00 kg	TCE	0 mol	0.53 kg	TCE	4 mol
0.00 kg	DCE	0 mol	0.39 kg	DCE	4 mol
0.00 kg	VC	0 mol	0.37 kg	VC	6 mol
3.32 kg		20 mol	1.95 kg		18 mol





Example 3: 100% PCE degrades to 20% PCE; 20% TCE; 20% DCE; 30% VC

Original Concentration			Final Co	ncentrat	<u>ion</u>
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0.00 kg	TCE	0 mol	0.53 kg	TCE	4 mol
0.00 kg	DCE	0 mol	0.39 kg	DCE	4 mol
0.00 kg	VC	0 mol	0.37 kg	VC	6 mol
3.32 kg	_	20 mol	1.95 kg	_	<mark>18 mol</mark>





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Example 4: Degradation with evidence of additional sourcing

Original Concentration			Final Concentration		
3.32 kg	PCE	20 mol	0.66 kg	PCE	4 mol
0.00 kg	TCE	0 mol	0.79 kg	TCE	6 mol
0.00 kg	DCE	0 mol	0.77 kg	DCE	8 mol
0.00 kg	VC	0 mol	0.50 kg	VC	8 mol
3.32 kg	_	20 mol	2.72 kg	_	26 mol





Example 4: Degradation with evidence of additional sourcing

Original Concentration			Final Con	<u>centration</u>	
3.32 kg	PCE	20 mol	0.66 kg	PCE	4 mol
0.00 kg	TCE	0 mol	0.79 kg	TCE	6 mol
0.00 kg	DCE	0 mol	0.77 kg	DCE	8 mol
0.00 kg	VC	0 mol	0.50 kg	VC	8 mol
3.32 kg		20 mol	2.72 kg		26 mol





Example 4: Degradation with evidence of additional sourcing

Original Concentration			Final Co	ncentrat	<u>ion</u>
3.32 kg	PCE	20 mol	0.66 kg	PCE	4 mol
0.00 kg	TCE	0 mol	0.79 kg	TCE	6 mol
0.00 kg	DCE	0 mol	0.77 kg	DCE	8 mol
0.00 kg	VC	0 mol	0.50 kg	VC	8 mol
3.32 kg	-	20 mol	2.72 kg	_	<mark>26 mol</mark>





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This analysis requires fixed data points within a fixed area for the purposes of assessing relative changes of area, average concentration, and mass indicator over time. Therefore, any created isopleth maps are not intended to be a depiction or model of the actual plume but rather is meant to show conceptual behavior of the aforementioned metrics over time.

Molar Trends: Plume A







Molar Trends: Plume C

This analysis requires fixed data points within a fixed area for the purposes of assessing relative changes of area, average concentration, and mass indicator over time. Therefore, any created isopleth maps are not intended to be a depiction or model of the actual plume but rather is meant to show conceptual behavior of the aforementioned metrics over time.





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Molar Trends: Plume B











Groundwater Plume Analytics Well Sufficiency Analysis

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This analysis requires fixed data points within a fixed area for the purposes of assessing relative changes of area, average concentration, and mass indicator over time. Therefore, any created isopleth maps are not intended to be a depiction or model of the actual plume but rather is meant to show conceptual behavior of the aforementioned metrics over time.

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Well Sufficiency Analysis Argument

Ricker Method [®] Well Sufficiency Argument							
	Comparison of Original Network to Reduced Network						
Strength of Argument	Primary Line	of Evidence	Secondary Lin	e of Evidence			
Strength of Argument	Trend via Mann-	Trend via Mann- Trend via Linear Relative Percent		Correlation			
	Kendall	Regression	Difference	Coefficient			
Very Strong	Same	Same	<10%	≥0.9			
Strong	Same	Same	<20%	≥0.8			
	Increasing/Stable	Increasing/Stable					
Marginal	or	or	<30%	≥0.7			
	Decreasing/Stable	le Decreasing/Stable					
Poor	Increasing/Decreasing	Increasing/Decreasing	>30%	<0.7			



Well Sufficiency Analysis Results

- Original Program
 - Cr+6: 76 wells
 - Other metals: 84 wells
 - VOCs: 84 wells
 - Quarterly monitoring
 - Quarterly reporting
 - Annual Cost: \$144,748

- Optimized Program
 - Cr⁺⁶: 42 wells
 - Other metals: 42 wells
 - VOCs: 37 wells
 - Every 3rd qtr monitoring
 - Annual reporting
 - Annual Cost: \$29,190





Thank you for the opportunity to present this information to you!

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